Population biology of *Sesarma rectum* Randall, 1840 (Decapoda, Grapsoidea, Sesarmidae) at Itamambuca mangrove in northern littoral of São Paulo state, Brazil.

Silva, S. M. J. and Chacur, M. M.

NEBECC- Depto. de Zoologia, IBB, UNESP, 18618-000, Botucatu (SP), Brasil

Abstract

The population biology of the semiterrestrial crab *Sesarma rectum* was studied from July, 1999 to June, 2000 at Itamambuca mangrove, Ubatuba (SP), Brazil. The obtained crabs (cpue, 2 collectors/30 min) were measured and distributed in 16 size classes. Size frequency presented unimodal distribution. Males and females median sizes were 22.9mm and 19.4mm (CW), respectively. Based on the allometric technique, all males smaller than 14.4 mm and females smaller than 13.3 mm of carapace width were considered as juveniles. The sex ratio was statistically different of 1:1 during the summer (α=5%). A decreasing abundance was observed during the last sampling month, probably, because of the difficulty of its larvae in settling on such estuary. Scarcity of food caused by substitution of grass (food source) for other typical mangle species (*Laguncularia racemosa*) can also be affecting the crab population dynamic.

Key words: Allometry, population structure, sex ratio.

Introduction

Throughout Grapsoidea evolutionary history, different developmental and reproductive patterns were experienced and, as a result, this superfamily shows a wide geographical distribution and its representatives occupy diverse habitats. Despite most of these crabs live at intertidal region, as much as at rocky littoral and estuary areas, some species have marine features, while others show a higher but variable level of terrestrially (Flores, 1996).

Due to this diversity, the superfamily Grapsoidea has been recently divided into six families: Plagusiidae, Sesarmidae, Grapsidae, Vanuridae, Gecarcinidae and Glyptograpsidae (Schubart *et al.*, 2002).

Seiple (1979) affirms that studies about sesarmid are particularly important because of their influence on the ecosystem. Their feeding activity contribute to the increasing of leaves decomposition speed and also facilitate nutrient liberation to mangroves (Robertson and Daniel, 1989).

The Sesarmid crab *Sesarma rectum* Randall,1840 inhabits burrows, avoiding external temperature variations. According to Powers and Bliss (1983), burrowing must be the most critical adaptation to land for many terrestrial crustaceans. Burrows offer protection against predators and attenuate external climate conditions. Furthermore, they are water and high humidity source, protecting crabs during hottest hours (Henmi, 1989b; Diesel and Schuch, 1998).

Studies on population frequency in small areas are increasingly more common because they provide fundamental information to understand dynamics and functioning of larger areas (Mantelatto *et al.*, 1995), besides they provide subsides for a better comprehension on ecological establishment of populations, focusing some aspects as seasonal abundance, population density, frequency distribution, dispersion and demographic proportions (Negreiros-Fransozo *et al.*, 1999).

Populations show dynamic behavior changing throughout time. Changes in population size implicate in complex ecological points, which are better understood when species-habitat relations and intra/

interspecific interactions are investigated. There are two process that affect population size: first, immigration and birth, which increase population size; second, emigration and death, which cause a decrease in number of specimens (Begon *et al.*, 1996).

In this context, the characterization of natural populations are considered source of knowledge mainly related to birth and death rate, recruitment and migration (Hutchinson, 1980).

The study of *S. rectum* population biology was proposed to come up with a better comprehension of the population, from Itamambuca mangrove, Ubatuba (SP), changes to variations in environmental factors that can change crabs metabolism influencing growth, reproduction, sex ratio, recruitment, population density, migration and crabs behavior.

Material and Methods

The crab *S. rectum* occupy mangroves in western Atlantic at Venezuela, Guianas and Brazil (from Amapá to Rio Grande do Sul) (Melo, 1996).

Crabs collection took place between July 1999 and June 2000 at Itamambuca mangrove (23^0 24'24''S and 45^0 00'45''N), using the method of catch per unit effort (cpue) during 30 minutes. This method was more efficient than traps because of the species ability to move very quickly. Crabs were separated in individual plastic bags, frozen and labeled according to collection date and site.

In the laboratory, the specimens were identified as to secondary sexual characters (abdomen morphology and number of pleopods). Females have semicircular abdomen with four pairs of pleopods, while males have triangular abdomen with two pairs of modified pleopods as gonopods.

A vernier caliper was used to measure carapace width (CW), length (CL), abdomen width (AW), chelar propodus width (CPW) and gonopod length (GL).

Crabs were distributed in 16 size classes with amplitude of 2 mm. As Normality test failed ($p<0.05$) a Mann-Whitney test with 5% significant level (Zar, 1996) was performed to compare the population median size among months.

Softwares Mature I and II (Somerton, 1980 a, b) were used to determine male and female sizes that correspond to puberty molt and a later separation between young and adult crabs by relative growth analysis.

Recruitment analysis was determined by the percentage of juveniles in each season and the proportions of young and adult crabs were compared by statistical software MANAP (Cury and Moraes, 1981) that analyzed contrasts between and within multinomial proportions by Goodman's test (1964, 1965). These results were analyzed at the 5% significance level.

In order to evaluate the sex ratio, a multinomial proportion comparison test was used (Goodman, 1964, 1965).

Results

A total of 227 specimens of *S. rectum* was obtained of which 128 were males and 99 females. Crab sizes varied from 6.6 to 34 mm and 5.7 and 31.5 mm (CW) of males and females, respectively. Mann-Whitney test revealed that differences in the median size between males (22.1 mm) and females (19 mm) were greater than would be expected by chance and there is a statistical difference.

Table I shows allometry results of different body parts. Adult males show isometry for the relation between GL *vs* CW, while young males show positive allometry. Young and adult females show positive allometry for the relation between AW *vs* CW.

Relative growth analysis of gonopod (males) and abdomen (females) revealed that puberty molt occur when males reach 14.4mm (CW) (fig. 1) and females 13.3mm (CW) (fig. 2). Fig. 3 corresponds to the size value in which 50% of females are morphologically mature.

The size frequency distribution for each season and throughout the year are shown on fig. 4. The percentage of males and females for each size class is represented on fig. 5.

When the total number of crabs was analyzed throughout the year, the sex ratio did not differ from 1:1; when it was analyzed for each season, statistical difference was observed between young and adult crabs throughout the year seasons (α=5%) (fig.6), except between young and adult females (α=5%), during the summer.

When size frequency distributions for each collecting month were plotted, there were size classes with no representatives, justifying the using of seasons as temporal units.

Table I: Allometry results of Abdomen Lenght (AL) and Gonopod Lenght (GL) related to Carapace Width (CW).

Relation	N	Sex	Intercept	F (a)	Inclination	F (b)	Ho=b=1.0 (t Test)	r ²
AW *vs* CW	23	YM	a=0.1077	9.68	b=1.6197	3.76	No	0.8662
	56	AM	a=2.2168		b=1.4124		No	0.9661
GL *vs* CW	16	YJ	a=0.0475	3.66	b=1.8121	61.9	No	0.8948
	93	AF	a=0.4319		b=0.9903		Yes	0.8924

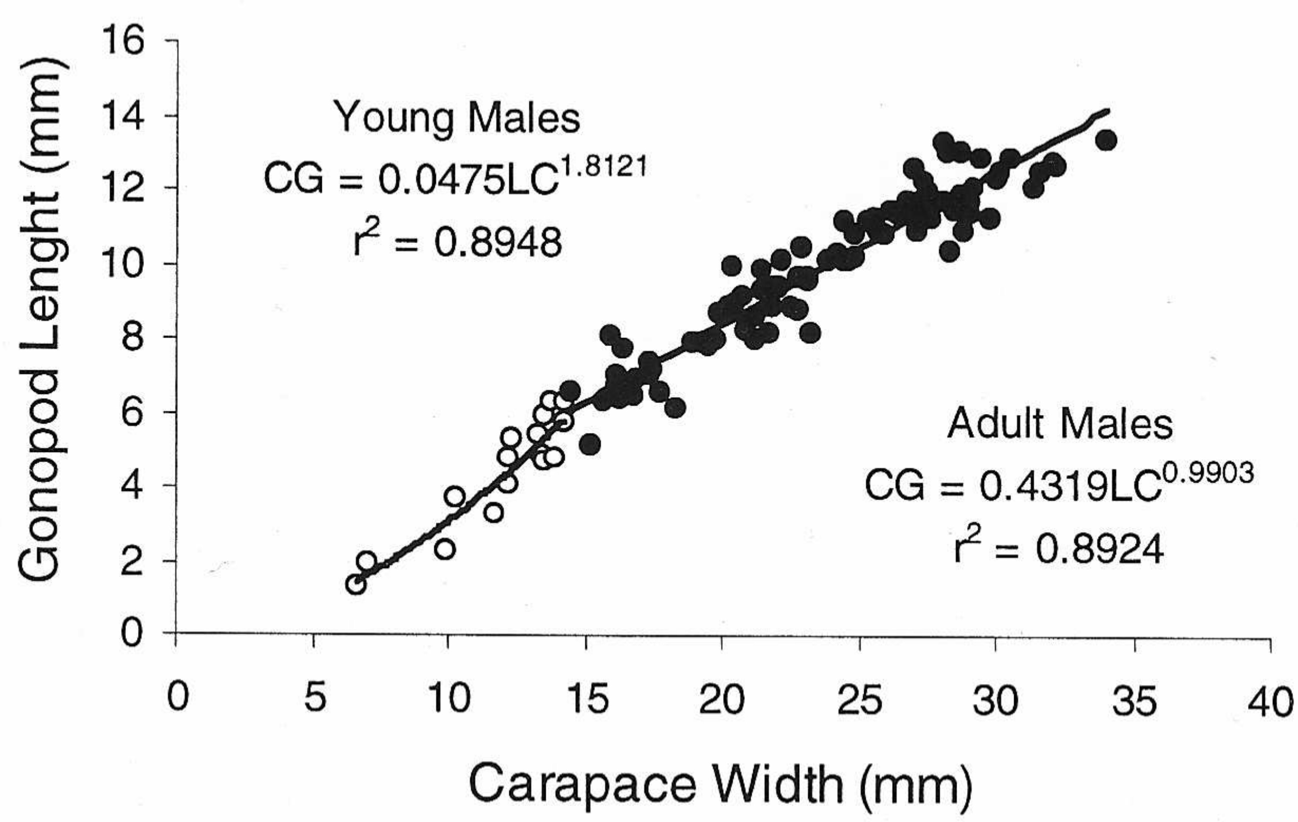

Figure 1: Relationship between gonopod lenght (GL) and carapace width (CW) for males (p<0.05).

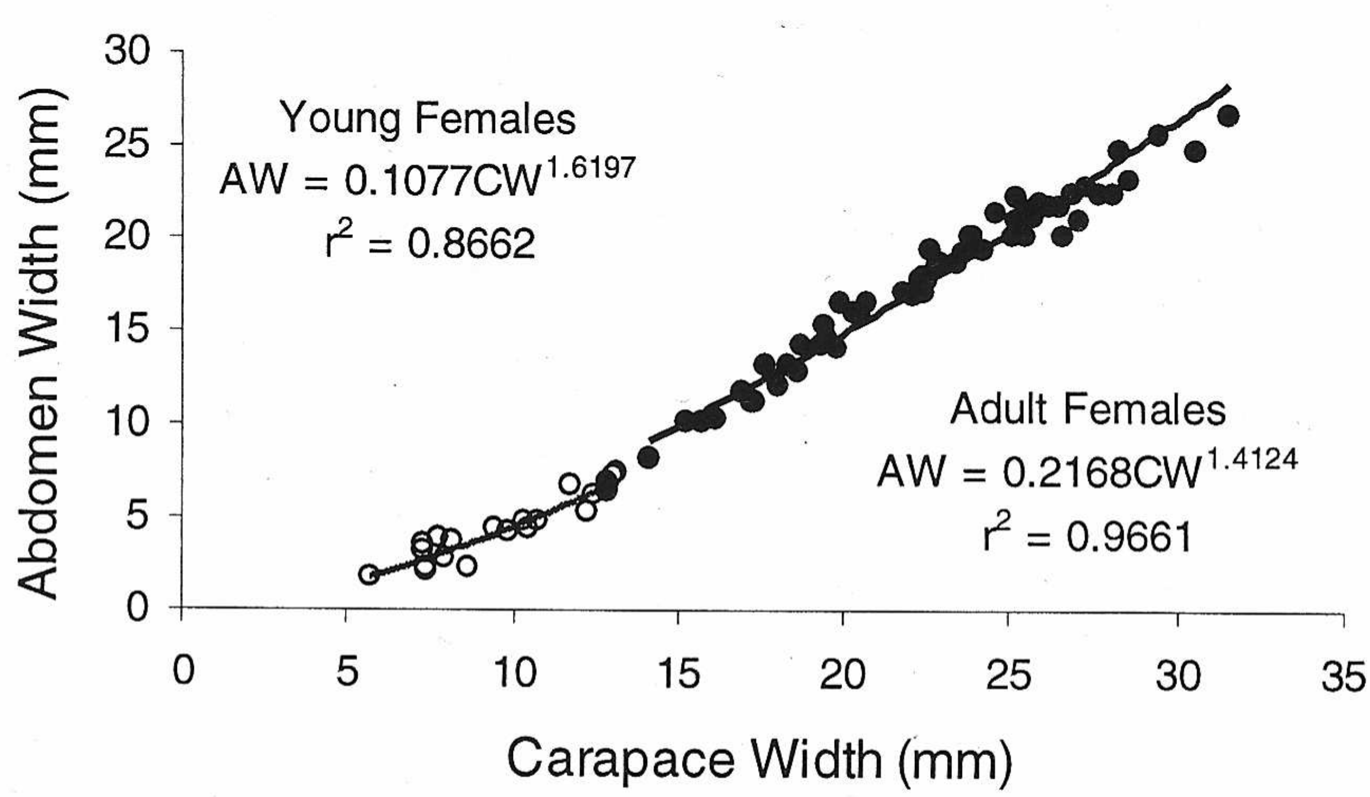

Figure 2: Relationship between abdomen width (AW) and carapace width (CW) for females (p<0.05).

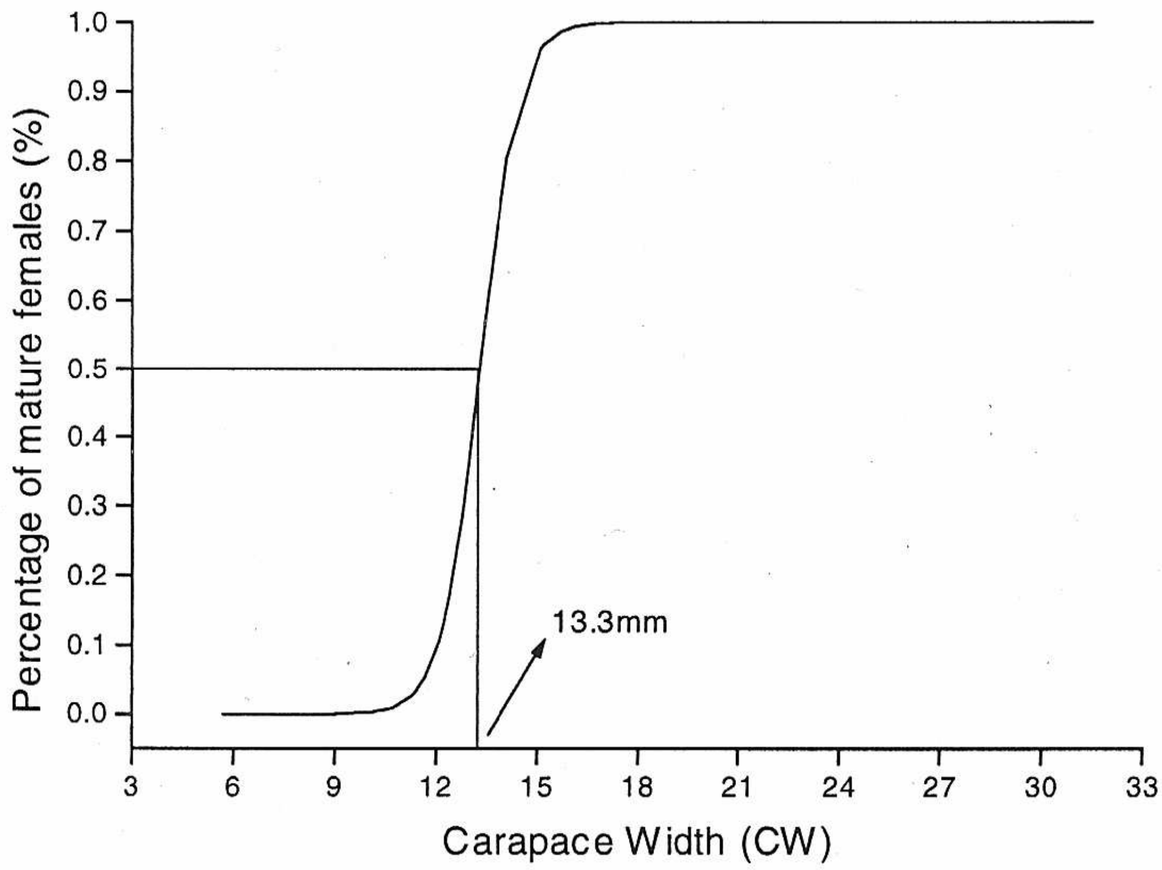

Figure 3: The logistic equation indicating where 50% of females are mature.

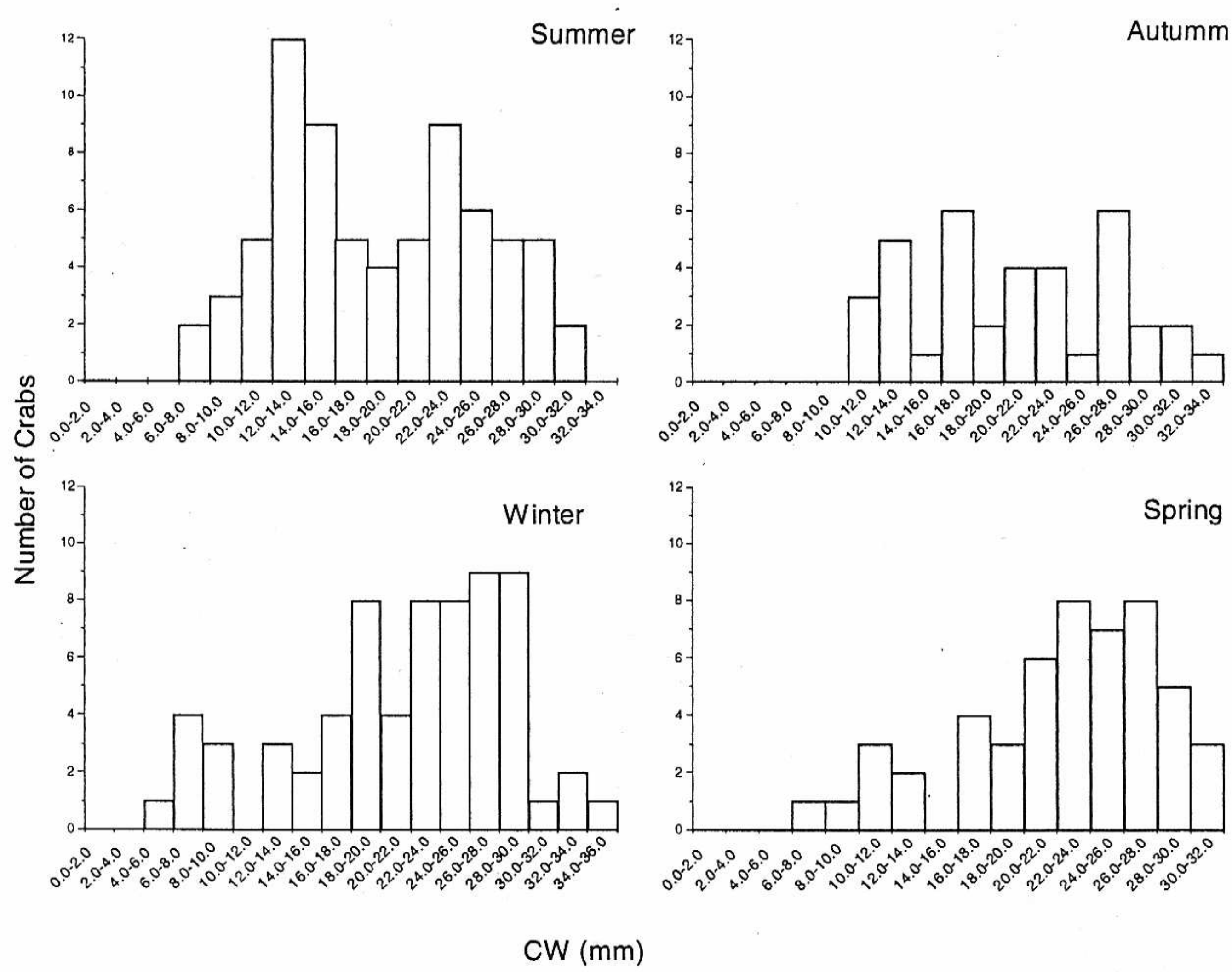

Figure 4: Size frequency distribution of *S. rectum* throughout the year seasons (CW, mm).

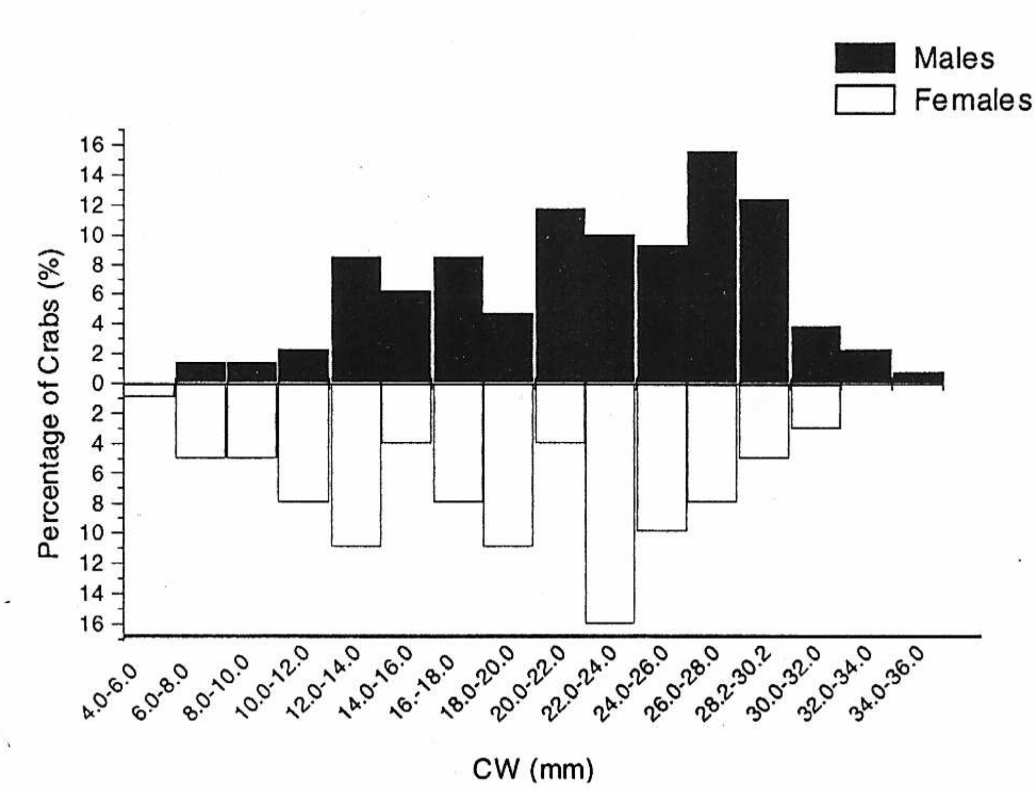

Figure 5: Percentage of males and females in each size class (CW, mm).

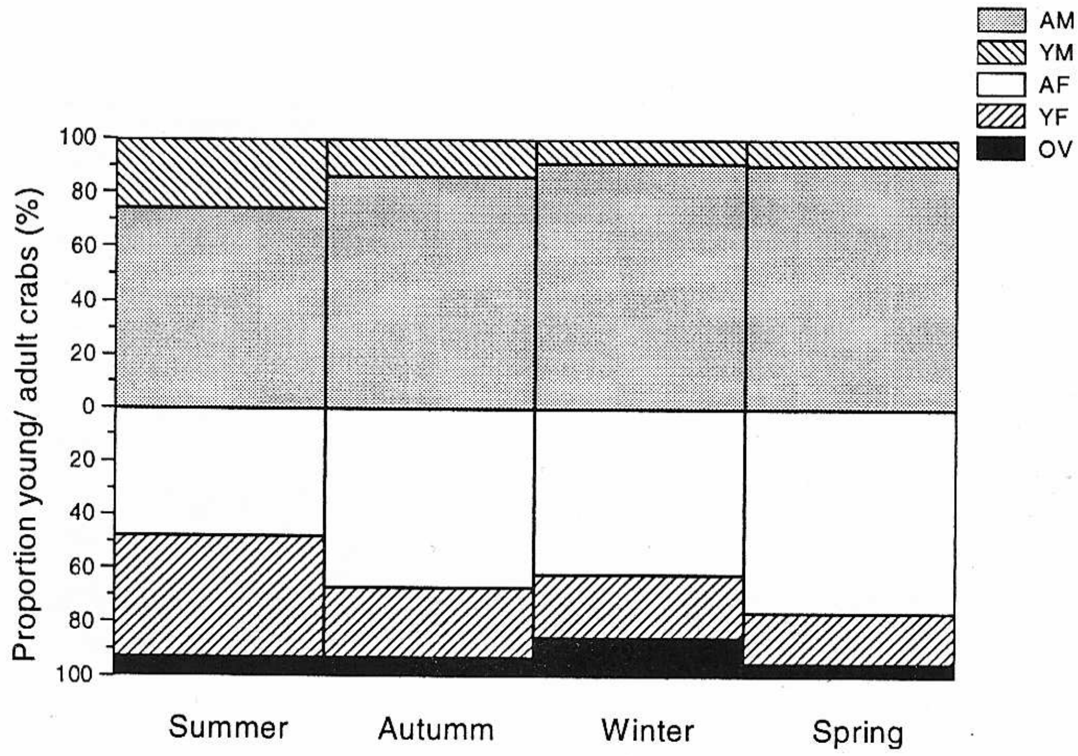

Figure 6: Proportion of young and adult crabs throughout year seasons. Young Male (YM), Adult Male (AM), Young Female (YF), Adult Female (AF) and Ovigerous (OV).

Discussion

The analysis of dimension changes in crustacean bodies that take place throughout their life history can determine sexual maturity in a morphological aspect. Those changes occur during the puberty molt (Perez, 1928) and their importance is related to the reproductive function in which some body parts are involved (Vannini and Gherardi, 1988).

As much as cheliped, the gonopod shows positive alometry in males at pre-puberty stage, while its growth attests negative alometry in females. The abdomen shows positive alometry for young and adult females, as confirmed in this paper. The female dispersion graph did not show overlap of straight lines because of the low number of crabs that was found at size classes between 13.0 and 15.0mm (CW), the band where puberty molt was determined.

When our results are compared to those of Mantelatto and Fransozo (1999) for the same species in Bertioga (SP) (table II), it can be seen that puberty molt occurs in similar sizes in both places. Environmental factors, as water quality, temperature (Somerton, 1981) and their combination with fotoperiod conditions (Hines, 1989) can influence the size in which crabs reach sexual maturity. The crabs population from Ubatuba and Bertioga occupy practically the same latitude, so climatic factors are similar, justifying the results obtained. However, more detailed studies about feeding preference of the species could come up with new comparative parameters.

Some researchers study crab maturity based on the smallest ovigerous female size (Sardá, 1991). Leme (1999), using this technique, found sizes of puberty molt that are larger than those shown in the present paper, however collection sites are very near (table II). She established that young crabs are smaller than 18.0 mm (CW) because her smallest ovigerous female was that size, but it does not mean that there are not any smaller females, considering the cryptic habit of *S. rectum,* promoting an inaccurate analysis.

Males median size was different than the one established for females, being the former bigger than ther latter. According to Gherardi and Micheli (1989), "males are larger than females probably because their best strategy for increasing their fitness is to grow quickly and reach the size which gives them most probability of winning in intra and/or intersexual competition and consequently copulating successfully. Female growth, on the contrary, is subject to two contrasting tendencies. A rapid growth could maximize their reproductive output because clutch size increases with animal size. On the other hand, energetic constraints make growth incompatible with reproduction.

Females reproductive activity delays the somatic growth and promote an increase of female number in some size classes mainly in the reproductive size classes (Díaz and Conde, 1989), as ascertained in the present paper, since the low number of ovigerous females that were found belong to most abundant size classes.

Table II: Size at sexual maturity established by different methodologies.

Study Sites	Sex	Size at maturity	Methodology	Author/year
Bertioga (SP) 23° 51'S 46° 09'W	M e F	±12.0mm (CW)	Relative Growth	Mantelatto and Fransozo (1999)
Ubatuba (SP) 23° 29'S 45° 09'W	M e F	±18.0mm (CW)	Smallest ovigerous female	Leme (1999)
Ubatuba (SP) 23° 24'S 40° 00'W	M F	±14.4mm (CW) ±13.3mm (CW)	Relative Growth	Present paper

However there was an accumulation in female number in some classes, the sex ratio did not differ from Mendel proportion (1:1). According to Fisher (1930), natural selection favor the 1:1 proportion, but after birth, some factors can cause a disequilibrium in the expected ratio. Mortality and growth influence, differently, males and females more than any other factor like nutrition, habitat, seasons (Wenner,1972), so they determine the predominance of one sex throughout developmental phases.

Frequency distribution was, in general, unimodal throughout the year and seasons. Díaz and Conde (1989) and Hartnoll and Bryant (1990) suggest that this distribution represents a population in equilibrium, with continuous recruitment and constant mortality. However, a decrease in crab numbers was observed during May and June/2000, the last month of collection.

The low number of crabs can be explained by the difficulty larvae of this species are facing to settle in this estuary. According to Christy (1989), two mechanisms have been proposed to explain how megalopae reach adult habitats. First, megalopae may remain near the bottom where residual flood-directed currents on the inner continental shelf (Scheltema, 1975) will carry them into estuaries (Johnson, 1985). Second, although megalopae may remain low in the water column during the day, they may move up at night and ride nocturnal flood tides (Christy, 1982; Epifanio *et al.*, 1988)

Hjort (1914) said recruits survival depends mainly on biotic and abiotic factors like food availability during the critical period (first meat) and transport mechanism from hatching area to growth-favorable environment (estuary). Larval settlement may not be happening because of wave strength at Itamambuca beach that carry larvae to adjacent estuaries. If larvae do not find a safe place to settle, the population dynamics is damaged.

Another hypothesis refer to environmental conditions. Since Itamambuca mangrove is still immature (Colpo, 2001) there is not a great food condition for all species, and just some are able to keep a population equilibrium (i. e., *Cardisoma sp.* and *Ucides sp.* that share the same area with *S. rectum* and species of genus *Uca*, which feed on organic matter of the sediment).

Species of some genera as *Sesarma*, *Cardisoma*, *Goniopsis*, *Ucides* and *Aratus* feed on, basically, vascular plants and also litter and young plant seeds. According to Brogim and Lana (1997), *S. rectum* is potentially omnivore. They can be, however, classified as functional herbivore because of the predominance of plant components found inside their stomachs.

The scarcity of food caused by substitution of grass (food source for *S. rectum*) by other typical mangle species (*Laguncularia racemosa*) can be influencing physiological process as reproduction, which affects population dynamics.

In order to clarify some of the questions brought up by this paper, it is proposed an study of larval settlement at this mangrove.

Acknowledgements

We would like to thank Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), for provinding financial suport (#98/15292-5 MMC; 01/07159-8 SMJS).

References

Begon, M., Mortimer, M. and Thompson, D. J. 1996. Population Ecology. A Unified Study of Animal and Plants. 3 ed. Blackwell Science, United Kingdom, 204pp.

Brogim, R. and Lana, P. C. 1997. Espectro alimentar de *Aratus pisonii*, *Chasmagnathus Granulata* e *Sesarma rectum* (Decapoda, Grapsidae) em um manguezal da baía de Paranagua, Parana. Iheringia Série Zoologia, 83, 35-43.

Christy, J. H. 1982. Adaptive significance of semilunar cycles of an hypothesis. Biological Bulletin, 163, 251-263.

Christy, J. H. 1989. Rapid development of megalopae of the fiddler crab *Uca pugilator* reared over sediment: implications for models of larval recruitment. Marine Ecology Progress Series 57, 259-265.

Colpo, K. D. 2001. Biologia populacional comparativa de uca vocator (Herbst, 1804) (Brachyura, Ocypodidae) em três localidades do litoral norte paulista. Master Science Dissertation, 103p. Unesp "Campus de Botucatu", São Paulo.

Curi, P. R. and Moraes, R. V. 1981. Associação, homogeneidade e contrastes entre proporções em tabelas contendo distribuições multinomiais. *Ciência e cultura*, 33, 712-722.

Diaz, H. and Conde, J. E. 1989. Population dynamics and life of mangrove crab *Aratus pisonii* (Brachyura, Grapsidae) in a marine environment. Bulletin Marine Science, 45, 148-63.

Diesel, R. and Schuh, M. 1998. Effects of salinity and starvation on larval development of the crabs *Armases ricordi* and *A. roberti* (Decapoda: Grapsidae) from Jamaica, with notes on the biology and ecology of adults. Journal Crustacean Biology, 18 (3), 423-436.

Epifanio, C. E., Little, K. T. and Rowe, P. M. 1988. Dispersal and recruitment of fiddler crab larvae in the Delaware River estuary. Marine Ecology Progress Series, 43, 181-188.

Fischer, R. A. 1930. The genetical therory of natural selection. 2ed. Oxford: Claredon Press, 291p.

Flores, A. A. V. 1996. Biologia de *Pachygrapsus transversus* (Gibbes, 1850) (Crustacea, Brachyura, Grapsidae) na região de Ubatuba, SP. Master Science Dissertation, 143p. UNESP, "Campus de Botucatu", São Paulo.

Gherardi, F. and Micheli F. 1989. Relative growth and population structure of the freshwater crab, *Potamon potamios palestinensis*, in the dead sea area (Israel). Israel Journal of Zoology, 36, 133-145.

Goodman, L. A. 1964. Simultaneouss confidence intervals for contrasts among multinomial populations. Annals of Mathematical Statistics, 35, 716-25.

Goodman, L.A. 1965. On simultaneous confidence intervals for multinomial proportions. Technometrics, 7, 247-54.

Hartnoll R. G. and Bryant A. D. 1990. Size-frequency distributions in decapod Crustacea – the quick, the dead, and the cast-offs. Journal Crustacean Biology, 10, 14-19.

Henmi, Y. 1989b. Reproductive ecology of three ocypodid crabs. II. Incubation sites and egg mortality. Ecological Research, 4, 261-269.

Hines, A. H. 1989. Geographical variation in size at maturity in Brachyuran crabs. Bulletin of Marine Science, 45(2): 356-368.

Hjort, J. 1914. Fluctuations in the great fisheries of northem Europe viewed in the light of biological research. Rapp. P. v. Reun. Cons. Int. Explor. Mer., 20, 1-228,.

Hutchinson, G. E. 1980. An introduction to population ecology. 5ed. New Haley and London: Yale University Press.

Johnson, D. F. 1985. The distribution of brachyuran crustacean megalopae in the waters of the York river, lower Chesapeake Bay and adjacent shelf: implications for recruitment. Estuarine, Coastal and Shelf Science 20, 693-705.

Leme, M. A 1999. Estratégia reprodutiva de duas espécies de grapsídeos (Crustacea, Brachyura, Sesarminae) de manguezais. UNESP Doctoral Thesis,108p.UNESP, "Campus de Botucatu", São Paulo.

Melo, G. A. S.1996 Manual de identificação dos Brachyura (Caranguejos e Siris) do litoral brasileiro. São Paulo: Plêiade, 604p.

Mantelatto, F. L. M., Fransozo, A. and Negreiros-Fransozo, M. L. 1995. Population structure of *Hepatus pudibundus* (Decapoda: Calappidae) in Fortaleza Bay, Brazil. Revista de Biologia Tropical 43, 265-270.

Mantelatto, F. L. M. and Fransozo, A.1999. Relative growth of the crab *Sesarma Rectum* Randall 1840 (Decapoda, Brachyura, Grapsidae) from Bertioga, S. Paulo, Brazil. Pakistan Journal of Marine Biology. (Mar. Res.) 5, 11-21.

Negreiros-Fransozo, M. L., F. L. Mantelatto and Fransozo, A. 1999. Population biology of *Callinectes ornatus* Ordway, 1863 (Decapoda, Portunidae) from Ubatuba (SP), Brazil. Scientia Marina, 63, 157-163.

Perez, C. 1928. Sur l'appareil d'accrochage de l'abdomen au thorax chez les Decapodes Brachyoures.

Comptè Rendú, 186, 461-463.
Powers, L. W. and Bliss, D. E. 1983. Terrestrial adaptations. In- The biology of Crustacea. Vol. 8 Environmental adaptations. Vernberg and Vernberg (ed). Academic Press, New York, 271-333pp.
Robertson, A. I., Daniel, P. A. 1989. The influence of crabs on litter processing in high intertidal mangrove forests in tropical Australia. Oecologia, 78, 191-198.
Sardá, F. 1991. Reproduction and molt syncrhonism in *Nephrops norvegicus* (L.) (Decapoda, Nephropidae) in the western Mediterranean: Is spawning annual or biannual? Crustaceana, 60, 186-199.
Scheltema, R. S. 1975. Relationship of larval dispersal, geneflow and natural selection to geographic variation of benthic invertebrates in estuaries and along coastal regions. In-Estuarine research, Cronin, L. E New York Academic Press, 373-391pp.
Schubart, C. D., Cuesta, J. A. and Felder, D. L. 2002. Glyptograpsidae, a new brachyuran family from Central America: larval and adult morphology, and a molecular phylogeny of the Grapsoidea. Journal of Crustacean Biology, 22 (1), 28-44.
Seiple, W. 1979. Distribution, habitat prefences and breeding periods in the crustacean *Sesarma cinereum* and *S. reticulatum* (Brachyura, Decapoda,Grapsidae). Marine Biology, 52, 77-86.
Somerton, D. 1980a. A computer technique for estimating the size of sexual maturity in crabs. Canadian Journal Fisheries Aquatic Science, 37: 1488-1494.
Somerton, D. 1980b. Fitting straight lines to Hiatt growth diagrams: a re-evaluation. Journal of Conseil International pour Exploration de la Mer, 39, 15-9.
Somerton, D. 1981. A. regional variation in the size of maturity of two species of tanner crab *Chionocetes bairdi* and *C. opilio* in the eastern Bering sea and its use in defining management subareas. Canadian Journal Fisheries Aquatic Science, 38: 163-174.
Vannini, M. and Gherardi, F. 1988. Studies on the pebble crab, *Eriphia smithi* MacLeay 1838 (Xanthoidea, Menippidae): patterns of relative growth and population structure. Tropical Zoology, 1: 203-216.
Wenner, A. M. 1972. Sex-ratio as a function of size in marine Crustacea. American Nature, 106: 321-350.
Zar, J. H. 1996. Biostatistical analysis. Upper Sadle River: Prentice-Hall, 662pp.

Received: 20th Aug 2002
Accepted: 20th Dec 2002